Science awareness and scientific literacy

by Léonie J. Rennie

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The Australian Science Teachers Association (ASTA) has directed two significant projects aimed at raising science awareness in the community. The ASTA Science Awareness-Raising Project and the School Community Industry partnerships in science (SCIps) projects were funded by the Commonwealth Department of Education, Science and Training as an outcome of the Commonwealth Government report entitled The Status and Quality of Teaching and Learning of Science in Australian Schools. Both projects are direct outcomes of recommendations of this report, and are based on the need for greater levels of scientific literacy in the Australian community. This article provides some background to these projects and describes, with examples drawn from ASTA journals, the nature of scientific literacy.

Introduction

Four years ago, the Commonwealth Government released a report entitled The Status and Quality of Teaching and Learning of Science in Australian Schools (Goodrum, Hackling, & Rennie, 2001) commissioned by the then Department of Education, Training and Youth Affairs. The report drew together the outcomes of research in both national and international contexts and from analysis of a wide range of data collected from major Australian stakeholders, including teachers, students, scientists and members of the community.[1]

Goodrum et al. (2001) concluded that scientific literacy should be the aim of school science education. However, they found that whilst the importance of science and the need for students to achieve scientific literacy was well accepted by teachers, science educators and researchers, the meaning of scientific literacy was not well understood. Also, the data indicated that, in many cases, the science curriculum implemented in schools was not likely to promote scientific literacy as an outcome. Further, various submissions and documents drew attention to widespread concern about a lack of science awareness in the Australian community.

Goodrum et al (2001) proposed a number of recommendations to advance the quality of science teaching and learning in Australian schools and to promote scientific literacy amongst the Australian people. The recommendations were underpinned by the conviction that science is an essential part of the education of all students. But, Goodrum et al argued, there is "little point in learning about science unless it is of benefit to people in their everyday life" (p. 165). The key to ensure benefit from learning science is to promote scientific literacy. These authors defined scientific literacy in terms of using science in everyday life, not about knowing a great deal about science as a body of knowledge, but rather knowing science as a way of thinking, finding, organising and using information to make decisions.

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Readers may know of the Programme for International Student Assessment (PISA) Project, managed by the Organisation for Economic Cooperation and Development (OECD). Its purpose is to assess literacy in reading, mathematics and science. Scientific literacy is defined by the PISA Project as "the capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity" (OECD, 1999). Goodrum et al (2001) considered this definition and others, and proposed that scientific literacy in their report would refer to helping to be interested in, and understand the world around them; to engage in the discourses of and about science; to be sceptical and questioning of claims made by others about scientific matters; to be able to identify questions, investigate and draw evidence-based conclusions; and to make informed decisions about the environment and their own health and well-being.

Projects to promote scientific literacy

One of a number of outcomes of the Goodrum et al (2001) report was a project managed by the Australian Science Teachers Association (ASTA) to develop and trial a science awareness-raising model that could be used at the "grass roots" level to increase the community's awareness of science and what science is about. Schools and their communities could use the model to identify a science-related issue of importance to the community and then undertake a small project to promote scientific literacy in ways that were appropriate to, and connected with, the real life circumstances of each community. In broad terms, each project aimed to promote greater understanding in the local community of why science is important, why time is spent on it at school and why knowing how to use science is a desirable outcome of schooling.

The science awareness-raising model was developed collaboratively with a cross-section of national stakeholder groups, including schools, principals, students, parents and members of the community including the scientific, business and industry sectors. With support from ASTA and the local Science Teachers Associations, the model was field tested in selected trial schools and their communities in all states and the ACT. A built-in evaluation plan assessed the impact of the local projects on raising science awareness within the school(s) and its(their) community, and the model and its resource guide was revised accordingly. The outcomes of this project are reported by Rennie and ASTA (2003).

In 2004, the Commonwealth and ASTA began a follow-up project, School Community Industry partnerships in science (SCIps, http://www.scips-asta.edu.au/home) and in first semester 2005, 24 projects in all mainland states and territories began. Each was built around the science awareness-raising model and resource guide now available in an online environment (http://www.scips-asta.edu.au/home/framework).

What is meant by scientific literacy?

The ASTA Science Awareness-Raising Project and SCIps both aimed to promote awareness of science among community members, most of whom have already completed their formal science education, and to support teachers to provide a science education that focuses on scientific literacy. Neither project was designed to teach science facts to the community. Instead their aim was to assist people to understand how

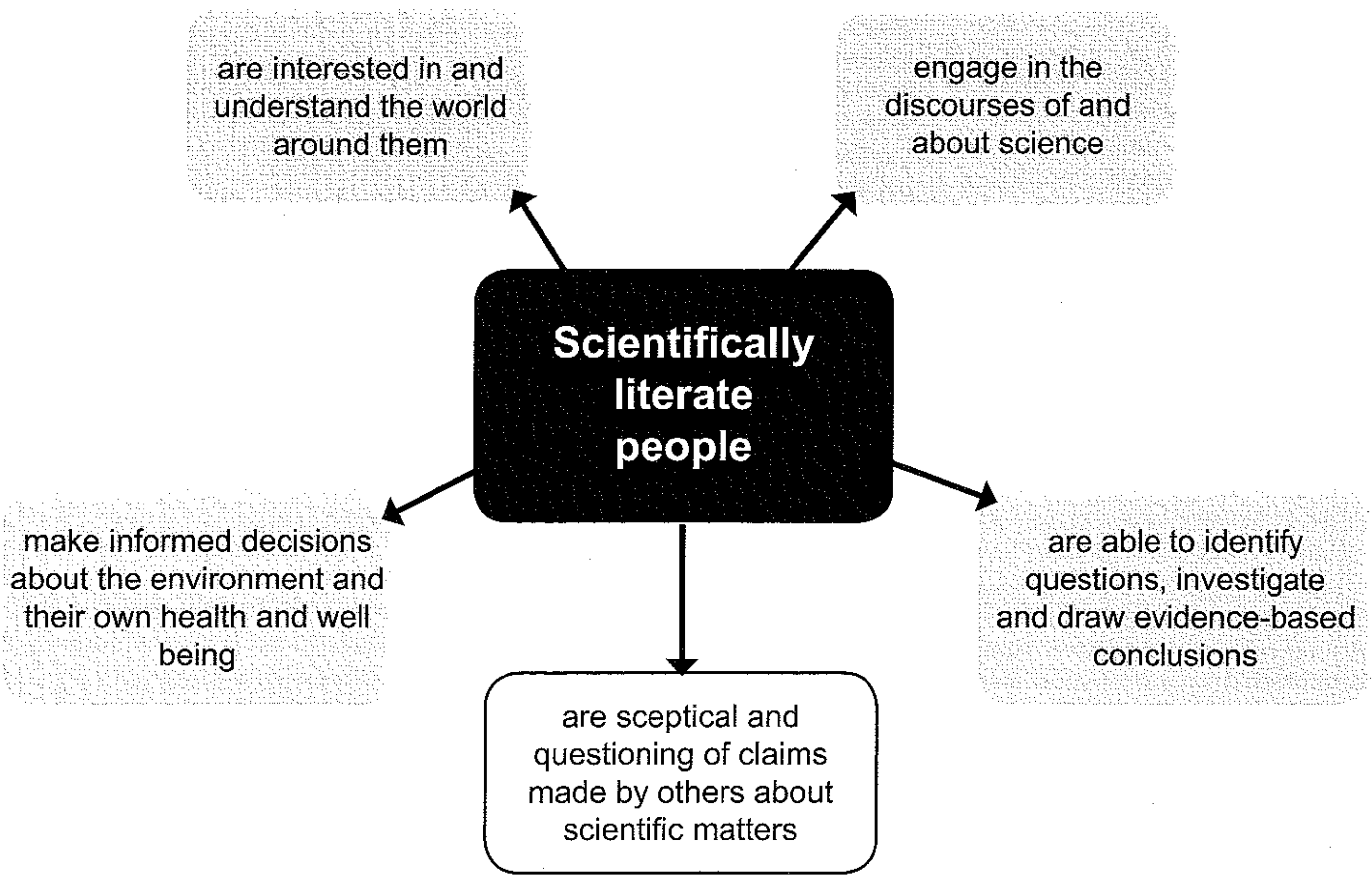

Fig. 1 ***A Definition of Scientific Literacy***

science is an integral part of what goes on in communities and how science can be used to make sensible decisions about people's health and well-being and the sustainability of their environment The projects aimed to get students working with community members outside of school, with flow on benefits of raised science awareness in the wider community, including the students' families

What does it mean to raise science awareness in the community? What does the definition for scientific literacy really mean for the teachers, students and the community? Goodrum et al. (2001) wrote that scientific literacy is a high priority for all citizens, helping them to be interested in, and understand the world around them; to engage in the discourses of and about science; to be sceptical and questioning of claims made by others about scientific matters; to be able to identify questions, investigate and draw evidence-based conclusions; and to make informed decisions about the environment and their own health and well-being.

By breaking this definition into its parts and unpacking it further, we can see more clearly what it is about. Figure 1 shows the parts of the definition To help clarify the meaning even further, the following discussion uses exemplars from recent issues of the ASTA journals to illustrate each aspect of scientific literacy, and especially how it might be achieved.

What does it mean to be interested in and understand the world around us?

Being interested in the world around us means being willing to involve ourselves in finding out about issues that affect us. Science is based on the notion that things happen for a reason; that events have rational explanations. Sometimes we don't have enough information to understand the reasons fully. Sometimes explanations are very complex. But we do understand a great deal about what happens in everyday life. Understanding means that we know enough, or can find out enough, to make sensible decisions and choices.

Exemplars: Palmer (2004) suggested some classroom techniques to promote students' interest. To enhance understanding, he emphasized the importance of teachers relating concepts to the students' lives. For example, he recommended using red food colouring (with which students would be familiar) instead of eosin dye to locate the xylem vessels in celery. Other exemplar activities linking science to the world around us abound in the resource booklets of ideas produced annually by ASTA for National Science Week.

What does it mean to engage in the discourses of and about science?

"Discourses" seems like a jargon word, but discourse simply means to talk or write about something in a formal or thoughtful manner. (Other words for discourse might be "discussion" or "communication" but they aren't quite as inclusive.) "Engaging in the discourses of and about science" means being able to read about and talk about science in a sensible and comfortable way. It means being able to participate in the communication of science, by reading and understanding labels on medicine and food products, for example, and following science-based arguments in the media In other words, it means not being frightened of science, but being willing to engage with it and recognise it as a way of looking at and helping to understand the world. Another way of putting it, is that people feel comfortable with science.

> **...a science education that promotes scientific literacy is more likely to result in a community that has an understanding of what science is about and knows how to use it.**

Exemplar: Symington and Tytler (2003) interviewed 15 community leaders about their views on the purposes of school science Very few had a formal education in science beyond secondary school, but all were life-long learners, and all stressed "the importance of schools providing the framework within which people can continue to learn" (p. 27) Interviewees gave examples of ways science could be used to assist them in their own work. "This is not just a matter of skills and knowledge but also feeling comfortable with science" (p 27), these authors concluded.

What does it mean to be sceptical and questioning of claims made by others about scientific matters?

You do not have to look far to find a topic about which there are conflicting views, all claiming to be science-based. There are many reasons why there are conflicting views on a particular topic. One reason is that sometimes a full scientific explanation is not yet available and the partial knowledge we have may be inconsistent. Another reason is that sometimes there are no clear-cut right or wrong answers, and decisions have to consider both risks and benefits. But often the reason is simply that science exists in communities of human beings and human beings don't always agree! Australian society encourages people to have their own views on issues and they may make decisions based on their own beliefs, to do with their experiences, religion, culture, financial position, etc. Sometimes decisions are based not on knowledge but on personal gain or preference without regard for the consequences

Because of these different ideas and views, people should not believe all they are told without question. If an issue is important to them, they need to examine the evidence carefully and critically.

Exemplars: Webpages are increasingly a source of information about scientific matters, but which ones can you trust? Lim, Horton and O'Haver (2004) provide some basic checks on reliability Teachers can make use of them to enable students to be more questioning about the reliability of the information they find. And of course, be warned that textbooks aren't always right either! Dymond (2002) gave just a few examples of favourite activities that don't work, or are wrongly explained in textbooks. A related matter is the credibility of the science that is portrayed in film and television. It makes for great class discussions. Look at www.intuitor.com/moviephysics to find a grading system for the quality of physics in popular movies!

What does it mean to identify questions, investigate and draw evidence-based conclusions?

This process is central to science and scientific thinking. When people want to know more about an issue they need to think carefully about it. They must figure out what it is they need to know and what questions to ask about it. Good questions point to the information or data to be collected by investigation. Information might be available at the library, the local council, the internet, a health provider, a government department, and so on. This information has to be sifted for its relevance and credibility, and then synthesised into answers to the questions asked. This is what it means to draw evidence-based conclusions; the answers or conclusions are based on the evidence gathered.

Exemplars: Morris (2004) presented a case study of a Year 2 teacher and her class whose implementation of a topic on toys modelled the investigative process. Children explored the topic, identified questions, investigated, reflected and shared their conclusions with parents and the school community. It is never too early to give students practice in asking questions, designing ways to answer them and drawing conclusions from the evidence. In a series of articles, Colvill and Pattie (2002a, 2002b, 2003a, 2003b) described how basic science skills might be developed to enable students to achieve scientific literacy.

What does it mean to make informed decisions about the environment and people's own health and well-being?

Many of the everyday decisions we make are based on our accumulated knowledge and experience and we often make them without much thought. But some decisions require more knowledge than we currently have. Knowing something about the science means that we know where to search for additional and relevant information about science-related issues that concern us. Once we have the evidence and conclusions we draw from it, we need to think about what personal, family, social or other factors should be considered in order to make an informed decision about the matter.

Exemplars: Assisting students to make informed decisions requires the embedding of science in contexts beyond the classroom. Students must be able to see the connections between science and the world outside, find ways to get information, and then use it in an appropriate way. Moulds' (2002) description of rich tasks shows how this can be done. He used examples of senior chemistry students learning about and considering water quality in the Brisbane River, and setting tasks requiring the searching out of environmental knowledge to determine a site to build an eco-tourism resort. Campbell and Robottom (2004) wrote about an integrated program for Year 4 students using the environment as the overarching theme.

Integrating science with other subject areas is almost a necessity when teachers assist students to think about science in the broader context of their own lives. If you can't get out of the classroom for field trips, Ribbe (2002) described hands-on ways of providing the virtual fieldtrip experience via some comprehensive resources available on the Internet. To help teachers get even more out of a real field trip, Mack (2002) described how to prime students through a virtual pre-trip!

One of the bases for making decisions in science is ethics. Newell (2003) gave some examples of how ethics can interact with science information to shape the decisions that might be made. Of course, ethics are tied up with a society's norms and values, and in a multicultural country such as Australia, whose values should prevail is a question that is nearly impossible to answer. Nevertheless, it is a question that cannot be avoided in science classrooms. Dawson's (2003) research suggested that adolescents may need assistance in identifying ethical dilemmas and although students may not change their beliefs, she found that increased understanding of the science behind the issue at least allowed students to justify the decisions that they made. In a broader sense, Van Rooy (2004) gave some guidelines on teaching controversial topics in the classroom.

Simply put, a science education that promotes scientific literacy is more likely to result in a community that has an understanding of what science is about and knows how to use it. Further, they will be confident to talk about science-related issues that concern them and know where to find the information they need to make decisions about the environment, their health and well-being.

Acknowledgement

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Footnotes

[1] Summaries of the primary, secondary and national aspects of this report can be found in Goodrum, Rennie and Hackling (2001), Hackling, Goodrum and Rennie (2001), and Rennie, Goodrum and Hackling (2001), respectively.